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HOW I DO IT

Brachytherapy (Seed Implantation) for Clinically Localized Prostate Cancer

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INTRODUCTION

Widespread use of prostate-specific antigen (PSA) as a screening tool has led to increased clinical detection of biopsy-proven prostate cancer at earlier stages [1,2]. A fundamental advantage of prostate brachytherapy (Fig. 1) over external beam irradiation in treating localized prostate cancer is the ability to increase dose delivery to a preplanned, geometrically confined target volume while sparing uninvolved normal structures. Placing the energy sources—Palladium-103 or Iodine-125—directly into the cancerous prostate permits administration of a radiation dose greater than can be delivered safely by external beam techniques. A recent report on 320 patients treated with prostate brachytherapy on an outpatient basis and followed for a median of 50 months (range 24–95 months), documented survival and local control rates equal to radical surgery for T1 and T2 staged patients. Additionally, long-term treatment related morbidity was infrequent and minimal [3].

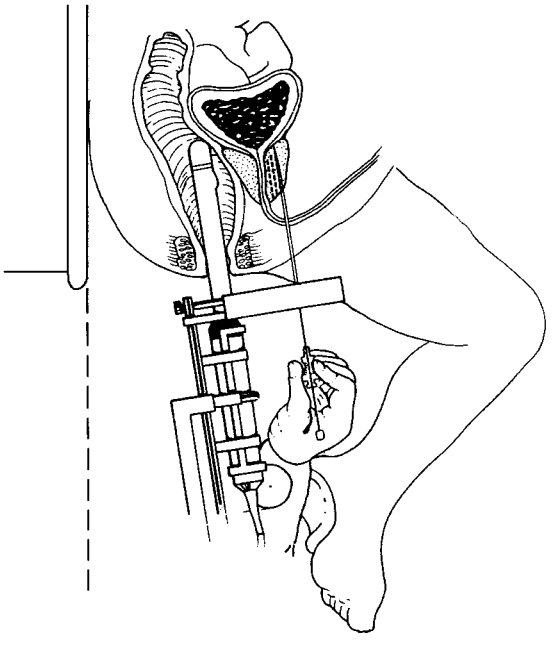

Fig. 1. Schematic illustration of modern transrectal ultrasound-guided implantation.

Essential to successful application of brachytherapy techniques are proper planning, technical expertise, and meticulous execution. As practiced today, prostate seed implantation is a three-step process: (1) pretreatment planning, (2) operative implant, and (3) postimplant quality evaluation.

PRETREATMENT PLANNING

Implant team. Prostate seed implantation requires both urological surgical skill and radiotherapeutic expertise and close cooperation between these specialties is of utmost importance.

Patient selection. Iodine-125 and Palladium-103 both emit low energy X-rays of limited tissue penetration. Therefore, implantation with these radioisotopes is suitable only for low volume tumors that are confined to the prostate.

Patients who have undergone prior transurethral prostate resections are at higher risk for postimplant urinary complications (stricture and incontinence). Such patients should be carefully counseled regarding such risks if they wish to undergo the implantation procedure.

Dose-computation. Prostate volume determination and rendering of its spatial geometry are achieved using transrectal ultrasound. Serial transverse images of the prostate and seminal vesicles are obtained at 5 mm intervals, with a matrix corresponding to channels in a multichannel puncture guide electronically superimposed on each image (Fig. 2). The images are entered into a treatment planning computer to determine the optimum

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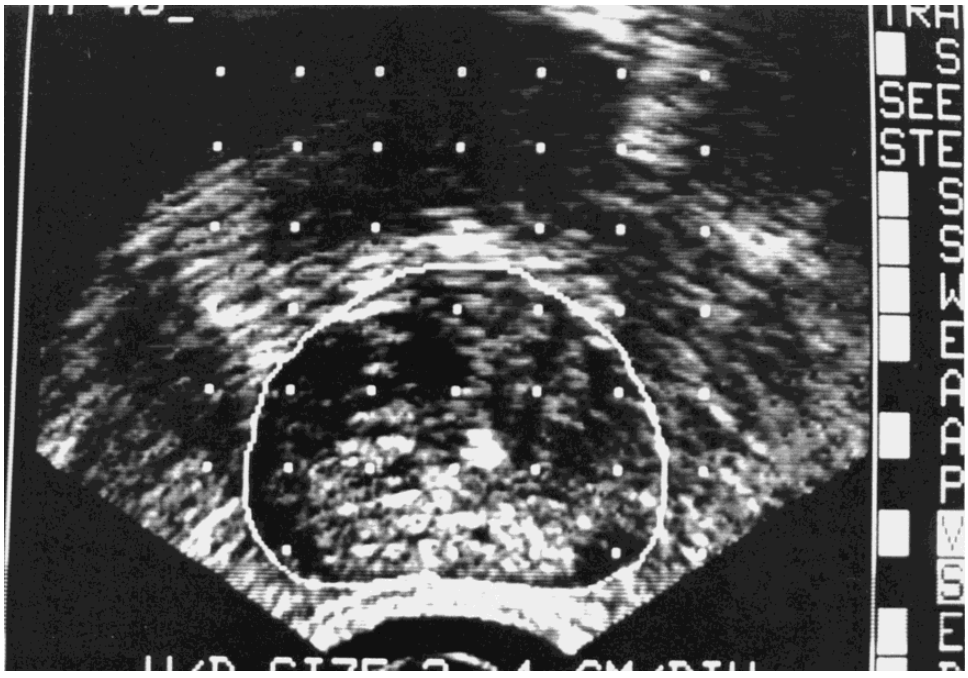

Fig. 2. Transverse, transrectal ultrasound image of midprostate with overlaid template coordinates and demarkated glandular margins.

seed configuration that will administer a minimal prescribed dose to the periphery of the prostate while sparing uninvolved normal structures (Fig. 3).

Isotope selection. Palladium-103 and Iodine-125 differ primarily in the rate at which they deliver the radiation. Palladium-103, with a half-life of 17 days, emits 24 cGy per hour; and Iodine-125, with a 60 day half-life, gives off 8 cGy per hour. Although no convincing clinical proof exists for selecting one over the other, some practitioners believe a more rapid rate of delivery promises to be more effective for neoplasms with a shorter cell cycle.

OPERATIVE IMPLANT

The implant procedure, requiring 45–60 minutes, is done under spinal anesthesia in the lithotomy position. Brackets fastened to the operating table support an external fixture to hold a biplanar, multifrequency endorectal transducer. A multichannel needle steering device, corresponding to the electronic grid matrix superimposed on the transverse ultrasound prostate images, is attached to the rectal probe. Scanning through the gland with the template coordinate grid activated, the probe is adjusted until the sequential images on the TV monitor correlate with similar images of the volume study. At that time the support brackets are locked in position.

The implant begins anteriorly and proceeds posteriorly to prevent target shadowing of already inserted seeds. Each needle is guided into its preplanned position in the gland under direct transverse and sagittal ultrasound observation. Attention to detail is critical during needle insertion so that movements of the gland may be recognized and compensated for. When a needle is correctly positioned as determined by the ultrasound image, the obturator is held stationary by an assistant while the needle is withdrawn. In this way, rows of alternated seeds and spacers are deposited into preplanned positions in the gland (Fig. 4).

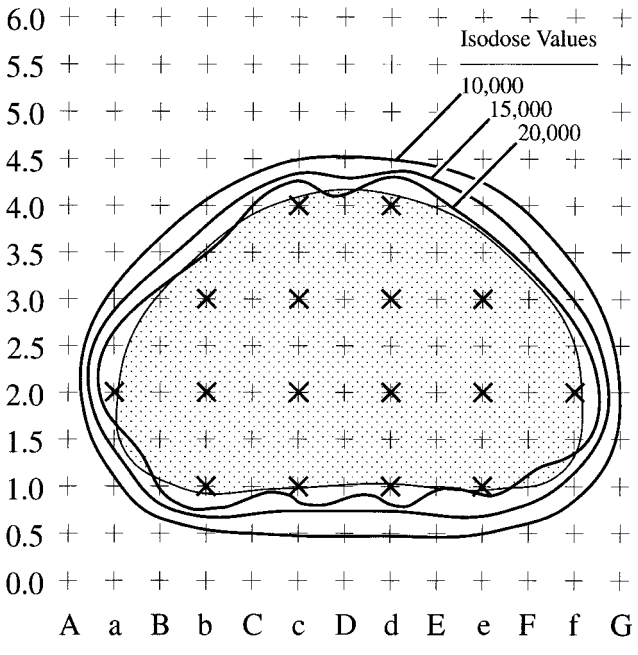

Fig. 3. Ultrasound-based computer image of transverse section of midprostate showing planned seed positions and resultant isodose coverage.

Fig. 4. Postimplant transverse CT image of prostate showing uniform seed distribution.

When the needle insertions are completed, a cystoscopy is performed and any stray seeds found in the bladder or urethra are removed and reloaded into needles for repeat insertion. Dosimetric evaluation of the implant is performed on every patient postoperatively using three-dimensional CT-based analysis. The evaluation consists of dose computation and dose analysis for the prostate and adjacent uninvolved structures, based on the actual implant. Five millimeter slice thicknesses are scanned using soft tissue density for the prostate and bone density for seed portrayal. The interactive, three-dimensional display of prostate slices and seeds is then computer analyzed and presented with isodose overlays. This slice-by-slice analysis permits detailed and accurate evaluation of the implant quality (Fig. 5).

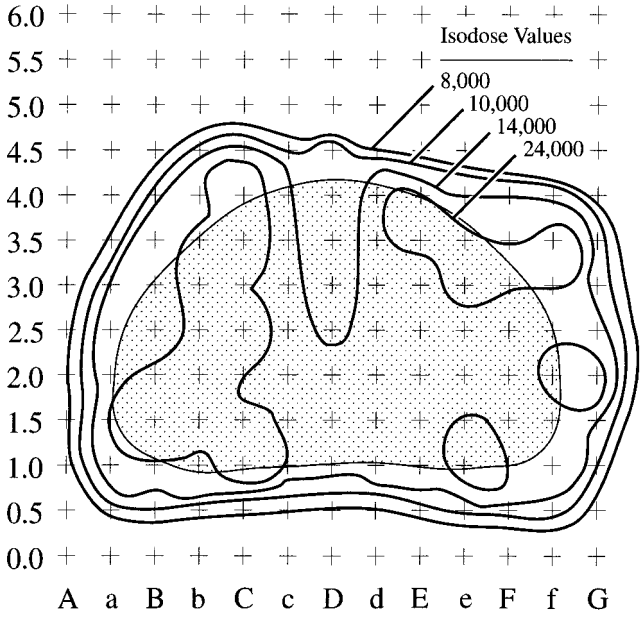

Fig. 5. Postimplant transverse prostate CT image showing isodose coverage obtained.

CONCLUSIONS

Transperineal seed implantation is a well-tolerated procedure that, in appropriately selected patients, is convenient, cost effective, and results in minimum morbidity and lifestyle impact. Although the definitive curative potential of this therapy awaits long-term follow-up, at 7 years the TRUS-guided implant procedure described achieves an actuarial local tumor control of 97% [3].

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